in the sod, there being no outer case, and no attachment. The usual hooks of the cremaster are not bent, but straight out and few. Now the *Erebia epipsodea*, and the three Chionobas which have been bred in this country, *C. chryxus*, *semidea*, and *jutta*, are like the *A. Galatea* in larval habits and appearance, and the pupa is unattached, and has actually no hooks at all. I read in Buckler, that *Satyrus Semele* actually makes a case underground (like some of the Sphingidæ), and is inside that like a Hesperid. It is to be supposed that many genera of the Satyridæ pupate unattached, or in cocoons. Mr. Scudder says the eggs of Satyridæ are very like the Hesperidæ, and has to admit the resemblances I have spoken of in the other two stages. But he passes over all this as a mere trifle, and insists that 'in the prime features,' as he calls it, of the imago, the Satyridæ 'out-rank all others.' Now what are the 'prime features' he tells about? They are two: one is that the pupa hangs by the tail, and that there is a regular progression from the Hesperid style of attachment through the Papilionidæ, the Lycænidæ and the Satyridæ; and that the flat ventral side of pupæ in what he calls the higher families, the Suspensi, is an evidence that once they or their ancestors were attached by a girdle, like the Papilionidæ. The other is the atrophied condition of the fore-legs, which is more extreme in the Satyridæ than in any other family, and reaches the last degree in Chionobas. He, in his 'Butterflies of New England,' now issuing, puts *Chionobas semidea* at the head of the North American butterflies, the top rung of the ladder, beyond which we can go no farther! This is what I call your attention to.

"When we used to study 'Euclid,' we sometimes proceeded by an apparently correct mode of demonstration, till we came to 'which is absurd,' and I hold that this conclusion of Mr. Scudder is absurd on its face. Here is a butterfly on the top of the White Mountains of New England. Its species is found nowhere else than in Labrador and in Colorado, in the latter on the loftiest summits. There is no difference between the three butterflies from the three regions, and yet they cannot have had any communication for untold ages. It is considered as a relic of pre-glacial times in the White Mountains. This butterfly lives in a semi-torpid condition through its short season, lies about on the rocks, has but a trifling power of flight, and dodges the high winds in crevices of rocks. To say that an insect which for perhaps 50,000 years has lived this sort of life, and has not changed in all that time, is the most advanced in the scale of North American butterflies, and so of all the world, is absurd and ridiculous! The wonder is that it has not lost the use of its wings. Therefore the argument is wrong somewhere that leads to such a conclusion. If the premisses are allowed to be correct, then the reasoning has a flaw.

"I do not believe there ever was any derivative progression from one family of butterflies to another. And we cannot say that the Papilionidæ are derived from the Hesperidæ (either because of six legs, or the epiphysis, or any other reason), or the Papilionidæ from the Lycænidæ, or the four-legged families from the six-legged. There is not in the rocks a particle of evidence of such a progression, and the whole thing is the merest fancy. Any differences between families are not owing to derivation, but to the development of each independently, like the rays of a fan. "W. H. EDWARDS."

NOTES.

WE regret to have to record the death of Mr. Warren De la Rue, F.R.S. He was born in 1815, and died on Good Friday, after a short illness, from pneumonia. Mr. De la Rue was a most devoted observer and munificent patron of astronomy, and in him and Balfour Stewart solar physics has lost its chief founders.

THE death is announced of Dr. Paul du Bois-Reymond, Professor of Mathematics at the Technical High School of Berlin, and formerly at the Universities of Freiburg and Tübingen. He was the author of two well-known mathematical works, and brother of the eminent physiologist of the same name. He was born on December 2, 1831, and died at Freiburg in Baden, on April 7.

THE Rev. J. H. Thomson, Vicar of Cradley, whose death is announced, had made what is described as an extensive and valuable collection of European plants, and it is understood that he has bequeathed them to the Worcestershire Naturalists' Museum.

THE National Union of Elementary Teachers has been holding its twentieth annual conference this week at Birmingham. The conference was opened in the Town Hall on Monday afternoon, when an address was delivered by Mr. R. Wild, the President-elect, on the report of the Education Commission, and on the latest edition of the Code. The defects of the existing system of national education were discussed at a crowded meeting on Tuesday evening. Mr. Chamberlain, in addressing this meeting, spoke of payment by results, in the sense in which the expression is now used, as a method which everyone condemns. "We want you," he said, "to show us a better way, and it is through such conferences as those which are now being held that Parliament and the Government may hope to find, tested by your practical experience, a substitute for a system which we desire to alter."

THE picture of Sir William Bowman, by Mr. Ouless, R.A., has, by special permission, been exhibited to subscribers in the Marsden Library of King's College, and has now been sent to the Royal Academy. The list of subscribers numbers 420, and will be closed on June 1.

SIR ROBERT BALL, the Royal Astronomer of Ireland, has just been elected an Honorary Fellow of the Royal Society of Edinburgh.

PROF. CORFIELD, M.D., has been elected a Corresponding Member of the Italian Association "Dei Benemeriti," and awarded a gold medal for his contributions to hygiene.

DR. SCHWEINFURTH arrived at Aden on March 23, on his return from a three months' stay in Central South Arabia. He has started for Europe, bringing a very interesting botanical collection with him.

THE *Japan Weekly Mail* says that Mr. W. Gowland, who has occupied a prominent place in the Imperial Mint at Osaka, has retired from the Japanese service. In 1872, Mr. Gowland was selected by Dr. Percy, of the Royal School of Mines, London, as Chemist and Metallurgist to the Japanese Government. His first task in that country was the organization of the metallurgical department of the Copper Mint and the establishment of chemical and metallurgical laboratories. He subsequently filled the posts of Technical Adviser and Assayer, and as such was directly responsible for the accuracy of the coinage. Amongst other reforms at the Imperial Mint he introduced a novel process by which crude copper could be converted into bronze coinage bars at one operation, and also elaborated processes for the coinage conversion. His investigations into the effect of bismuth on the ductility of silver are well known. He made many interesting discoveries amongst the tumuli and shell-heaps in the interior. The Emperor conferred several distinctions on him before his departure.

THE Berlin Academy of Sciences has lately been presenting various sums of money to promote scientific research. Dr. Franz-Stuhlmann, assistant at the Würzburg Zoological Institution, has received £50 (Mk. 1000) to enable him to proceed with his investigation of the fauna of Zanzibar, where he has been since last spring. A sum of £60 (Mk. 1200) has been sent to Dr. Gustav Weigand to help him in his linguistic and ethnographical researches in the Balkan peninsula; and Dr. Pomtow has received £25 (Mk. 500) towards the publication of his work on Delphi.

A CORRESPONDENT in Paris writes to us that the British Section of the Paris Exhibition is nearly ready, and is much in advance of most other parts of the Exhibition.

THE following are the dates of some of the Exhibition Congresses which are to be held in Paris:—Technical Education, July 8 to 12; Bibliography of the Exact Sciences, July 16 to 26; Chemistry, July 29 to August 3; Ballooning, July 31 to August 3; Pigeons, July 31 to August 3; Hygiene, August 4 to 11; Higher Education, August 5 to 10; Physiological Psychology, August 5 to 10; Geography, August 6 to 11; Photography, August 10 to 17; Criminal Anthropology, August 10 to 17; Primary Education, August 11 to 19; Horticulture, August 16 to 21; Prehistoric Man and Remains, August 19 to 26; Electricity, August 24 to 31; Chronometry, September 2 to 9; Mines and Metallurgy, September 2 to 11; Applied Mechanics, September 16 to 21; Meteorology, September 19 to 25; River Utilization, September 22 to 27; Commerce and Industry, September 22 to 28; and Hydrology and Climatology, September 30 to October 15.

LECTURES will be delivered in Gresham College, on April 30, and May 1, 2, and 3, by Dr. E. Symes Thompson, on the medical aspects of life assurance.

AT a recent meeting, the Liverpool Geological Society appointed a Committee to report on the boulders occurring in the glacial deposits of Liverpool and district. This Committee, after full discussion, has reported that the investigations would be better carried out if extended over the whole of Lancashire and Cheshire, and by a larger Committee, consisting of representatives from all parts of the two counties. The objects of the enlarged Committee would be to examine and record the occurrence, nature, and facts bearing on the mode of transport, of erratics in the glacial deposits of Lancashire and Cheshire. If this suggestion meets with general approval, a meeting of all interested in the question will be held at some convenient centre at an early date.

IN a paper reprinted in NATURE (vol. xxxiv. pp. 220, 239), M. A. Blytt gave his views on variations of climate in the course of time. Believing that periodical variations of climate are to be attributed to changes in the strength of ocean-currents, he finally traced back their origin to the precession of the equinoxes and the eccentricity of the earth's orbit. He has now issued a paper, with two supplementary notes, in which he seeks to explain the displacement or alteration of beach-lines, by changes in the tidal-wave, caused by variations in the eccentricity of the earth's orbit. Referring to his former conclusions, that dry periods should be marked by chemical deposits, and rainy periods by mechanically-formed sediment, he passes on to consider the character of the Tertiary strata in the Paris and Hampshire Basins. In the author's opinion, the alternation of sediments of different nature indicates periodical variations in climate; and he endeavours to correlate these variations with particular phases in the eccentricity of the earth's orbit, the period or duration of which has been calculated in years. The author also believes that the lengthening of the sidereal day has had much influence on the form of the globe. This lengthening has been caused mainly by the tidal wave, and as the centrifugal force diminishes under such circumstances, strain accumulates in the solid earth, until the limit of resistance is reached. Hence, in the author's opinion, arose vertical displacements of beach-lines.

A REPORT from Sumatra states that the volcanic crater on the west coast of the island, which has been quiet for several centuries, was active during the middle of February.

SEVERE shocks of earthquake, lasting for eight seconds, were noticed at Zvornik in Bosnia, on April 2. The direction was from south to east.

WE have received from the Deutsche Seewarte, the second part of the *Deutsche Ueberseeische Meteorologische Beobachtungen* (see NATURE, vol. xxxvii. p. 444) containing complete observations made at six stations in Labrador during the year 1885, and at one station in Walfisch Bay (south-west coast of Africa) during the year 1887. Both sets of observations are carried on under considerable difficulties; in Labrador the rain-gauges are frequently inaccessible on account of drifting snow-storms, and the ordinary hygrometers are unmanageable during very low temperatures. In Walfisch Bay the thermometers are often choked by sand, or are liable to be affected by the intense radiation from the ground. Nevertheless the work supplies very valuable materials from remote regions where little is yet known about the peculiarities of the climate.

A CARBOHYDRATE of the empirical composition $C_6H_{10}O_5$, and possessing properties very closely resembling those of the arabin of "gum arabic," has been artificially prepared by Prof. Ballo, of Buda-Pesth. This achievement is the outcome of an attempt to reproduce the conditions under which the acids of the vegetable world are reduced by chlorophyll. It was assumed that the iron of chlorophyll is present in the ferrous state, and tartaric was the acid upon which operations were commenced. About equal quantities of tartaric acid and ferrous sulphate were dissolved in a minimum bulk of water, and the solution was warmed upon a water-bath. In a short time a greyish-yellow precipitate began to separate. The whole was then evaporated until it completely solidified on cooling. The cold mass was next extracted with alcohol and the extract again evaporated. The residue thus left by volatilization of the alcohol was neutralized with milk of lime, and the filtered solution again placed on the water-bath. It was now noticed that as the water was gradually expelled the contents of the evaporating dish became more and more viscid, until, finally, a sticky mass was left, reminding one most forcibly of gum arabic. Knowing that this familiar article of commerce chiefly consisted of the calcium and potassium compounds of arabin, the likeness was felt to be somewhat indicative of the formation of an arabin-like substance. On allowing the concentrated syrup to cool, a calcium salt readily crystallized out, yielding on analysis numbers pointing to the formula $(C_6H_9O_5)_2Ca + 9H_2O$. From this the free carbohydrate was obtained in two ways, either by precipitation of the solution in water with lead acetate and subsequent decomposition of the lead salt with sulphuretted hydrogen, or by addition of the calculated quantity of oxalic acid. The syrup of "iso-arabin," as it is provisionally termed, was further purified by repeated treatment with alcohol and ether and subsequent re-evaporation. It was then allowed to stand over sulphuric acid, some specimens for a month and others so long as a whole year. Each of these specimens, on combustion, yielded numbers indicating the empirical formula $C_6H_{10}O_5$. Iso-arabin is an almost colourless syrup, readily mixing with water. It does not reduce Fehling's solution, but rotates the plane of polarization to the right. It behaves, in short, exactly like the carbohydrates of the $(C_6H_{10}O_5)_n$ group. The potassium salt, obtained by decomposing the calcium salt with potassium carbonate, also crystallizes well in large anhydrous crystals. In addition to iso-arabin itself, a small quantity of its hydrate, $C_6H_{10}O_5 + H_2O$, is also formed by the action of ferrous sulphate upon tartaric acid, and separates out in crystals from the alcoholic washings of the crude iso-arabin.

Natural arabin itself forms a similar hydrate, the precipitate formed by addition of hydrochloric acid and alcohol to a solution of gum-arabic, when dried at 100° C., possessing this composition.

Mr. Fletcher, of Warrington, has recently put in the market a new and very cheap sensitive flame. It consists of a special arrangement of the small Argand bunsen, and differs from other sensitive flames inasmuch as any considerable sound completely extinguishes it. An interesting point in connection with it is that its sensitiveness is not constant, but apparently varies with the atmospheric conditions. The circular issued with the burner particularly states that the transparency of the flame renders it unsuitable for lecture experiments.

Mr. W. A. Hollis writes to us from Brighton, describing a dream in which rooms and things in his house seemed to be in their relative positions, but transposed. The displacement extended itself to a servant, who appeared to be dusting some furniture; the cloth she was using she held in her left hand. This experience suggests to Mr. Hollis the question, "Is it possible that in dream-land we see things as in a looking-glass, like our little friend Alice?"

Pisciculturists will read with interest M. Albert Le Play's pamphlet on the rearing of carps. It is entitled "La Carpe," and contains many new facts and suggestions concerning this branch of pisciculture.

Among foreign works which have been translated into French during the last two years, and the translations of which have been considered worthy of a reward, we notice two English books. The one is Mr. Green's "Short History of the English People"; the other Darwin's "Life and Correspondence," translated by M. H. de Varigny. The two other works to which, with the preceding, the Prix Langlois has been awarded, are Janssen's "Germany under the Reformation," and Nordenskiöld's "Travels." It is interesting that a book on Darwin should have been rewarded by the French Academy. M. Renan and M. Taine were on the jury, and did much to bring about the result.

We have received the first three numbers (January to March 1889) of the *Bulletin international de l'Académie des Sciences de Cracovie*. The ordinary transactions of the Cracow Academy, being published in Polish, are not accessible to scientific students unfamiliar with the Slavonic languages. To remedy this inconvenience the Academy will henceforth issue a monthly *Bulletin* containing extracts in French and German of its regular proceedings, as well as summaries of all important memoirs in one or other of these languages at the option of the authors. Besides several historical, philological, and antiquarian papers, the present numbers contain contributions by Prof. Kreutz on the granites of Volhynia containing tourmaline and garnets; by M. Olszewsky, on an improved method for liquefying and solidifying the permanent gases and for studying their spectra; by M. Krzyzanowski, on the liquefaction and solidification of hydrogen in M. Pictet's experiments; by M. Olearski, on the elasticity of zinc and copper alloys; and by M. Sawicki, on the influence exercised by the physical and chemical agents on the electric properties of the nerves.

The removal of tattoo-marks is a matter of no little difficulty, and many different methods have been tried (blistering, suction, thermo-cautery, counter-tattooing with white powder or milk, &c.). Criminals sometimes pour vitriol on their arms or hands, and letting it act for a few seconds, plunge the limb in water. The following method is recommended by M. Variot (in the *Revue Scientifique*):—The skin is first covered with a concentrated solution of tannin, and re-tattooed with this in the parts to be cleared. Then an ordinary nitrate of silver crayon is rubbed over these parts, which become black by formation of tannate of silver in the superficial layer of the dermis. Tannin powder is sprinkled on the surface several times a day for some days to dry it. A dark crust forms, which loses colour in three or four days, and, in a fortnight or so, comes away, leaving a reddish scar, free of tattoo-marks, and, in a few months, little noticeable. It is well to do the work in patches about the size of a five-franc piece at a time. The person can then go on with his usual occupation.

From a report of the Belgian Consul-General in the Congo State, it appears that the efforts made to introduce European vegetables and fruits in that district have been rewarded with very great success. The Government has imported tobacco-seed from Havana and Sumatra, which is cultivated in conjunction with native tobacco. The natives cultivate tobacco badly, but efforts are being made by the Government to teach them better methods. The inhabitants of the Lower Congo have been very successful in cultivating not only the usual African products, such as manioc, sweet potato, &c., but also sorghum, maize, and the "wandu" haricot, called "Boma" by the natives. The cotton-plant grows in its wild state, and the natives manufacture from it hats, wallets, &c. No effort has yet been made to cultivate it for trade purposes.

The American Commercial Agent at Limoges, in a report on the result of the sanitary investigation as to the effect of plastered wines—that is, wines to which sulphate of lime has been added—says that the practice is very ancient, and one about the evil effects of which the highest hygienic authorities have differed. The Academy of Medicine has held special meetings and discussed the subject at great length. The advantages claimed for the practice are that fermentation is increased very much; that it is more rapid and complete; that the wine keeps longer when it has been plastered, and that the colour is richer and more lasting. It is now settled, however, that plastered wines have occasioned functional troubles, as, for instance, in the Department of Aveyron, where, the doctors report, those who consumed plastered wines suffered from an unquenchable thirst, an insupportable dryness of the throat, and various other troublesome symptoms. The action of sulphate of lime on the bitartrate of potash in ordinary wine produces an acid sulphate of potash; and in wine treated with lime, sulphuric acid in a free state is formed, and sulphate of magnesia; and these combined act as a purgative and sometimes as a caustic. M. Marty, who was appointed by the Academy of Medicine to report on the practice of plastering, examines all the arguments adduced in favour of the process, and, on his recommendation, the Academy condemns the custom as being detrimental to health.

The British Consul-General in Algeria, in his report to the Foreign Office, says that hitherto the Government have been in the dark as to the habits and natural history of the locusts which now and then work such ravages in Algeria. Last year, however, a distinguished naturalist, M. J. Künckel d'Herculais, President of the Entomological Society of France, was sent to study the question on the spot, and he has published two reports on the subject. The species of locust which has ravaged the country since 1885 is not the same as that which invaded the same district in 1876–77. The former is *Stauronitis maroccanus*, the latter *Acridium peregrinum*. The former is found in most of the countries bordering on the Mediterranean, especially in Asia Minor and Cyprus. Morocco is, however, its original home, where it was observed in 1845, and again in 1867. Specimens of it collected in both those years still exist. Hitherto the accepted theory has been that they are brought from the desert by a strong southerly wind, but M. Künckel says that none have ever been observed in the Sahara, and he believes them to have their origin in the mountainous regions of Hodna. Fortunately the exact moment of their appearance may be predicted, and steps can be taken to destroy them. With this object M. Künckel has made charts of the localities where they laid their eggs last autumn, and has arranged a methodical system of campaign. The destruction of eggs is an uncertain and expensive process, he thinks, whereas one man can destroy a million young insects in a day.

A CHINESE native paper published recently a collection of some zoological myths of that country, a few of which are worth noting. In Shan-si there is a bird, which can divest itself of its feathers and become a woman. At Twan-sin-chow dwells the Wan-mu Niao (mother of mosquitoes), a fish-eating bird, from whose mouth issue swarms of mosquitoes when it cries. Yung-chow has its stone-swallow, which flies during wind and rain, and in fine weather turns to stone again. Another bird when killed gives much oil to the hunter, and when the skin is thrown into the water it becomes a living bird again. With regard to animals, few are so useful as the "Jih-kih" ox, found in Kansuh, from which large pieces of flesh are cut for meat and grow again in a single day. The merman of the Southern Seas can weave a kind of silky fabric which keeps a house cool in summer if hung up in one of the rooms. The tears of this merman are pearls. A large hermit-crab is attended by a little shrimp which lives in the stomach of its master; if the shrimp is successful in its depredations the crab flourishes, but the latter dies if the shrimp does not return from his daily excursions. The "Ho-lo" is a fish having one head and ten bodies. The myths about snakes are the strangest of all. Thus the square snake of Kwangsi has the power of throwing an inky fluid when attacked, which kills its assailants at once. Another snake can divide itself up into twelve pieces, and each piece if touched by a man will instantly generate a head and fangs at each end. The calling snake asks a traveller "Where are you from, and whither are you bound?" If he answers, the snake follows him for miles, and entering the hotel where he is sleeping, raises a fearful stench. The hotel-proprietor, however, guards against this by putting a centipede in a box under the pillow, and when the snake gives forth the evil odour, the centipede is let out, and, flying at the snake, instantly kills him with a bite. The fat of this snake, which grows to a great size, makes oil for lamps and produces a flame which cannot be blown out. In Burmah and Cochin-China is a snake which has, in the female sex, a face like a pretty girl, with two feet growing under the neck, each with five fingers, exactly like the fingers of a human hand. The male is green in colour, and has a long beard; it will kill a tiger, but a fox is more than a match for it.

A SERIES of regulations with regard to patents and designs has just been issued in Japan. All inventors, whose discoveries are beneficial or are calculated to improve existing processes of manufacture, may apply for letters patent. No patents, however, will be granted in the case of articles of food or drink, or in case of medicines. Inventors who do not receive letters patent are powerless to sue in respect of piracy of their inventions. In order to register an invention, application must be made to the Patents Bureau, and if the officials are satisfied as to the genuineness of the invention, it is registered, on certain forms being complied with and certain fees paid. A curious omission occurs in the regulations, but it is not plain whether it is intentional or not. Nothing whatever is said as to the rights of a foreigner to patent an invention, but it is presumed that he will not be able to do so. Nor has any provision been made for advertising applications for letters patent. The Patents Bureau is to be the sole judge of all cases submitted to it, and from its decision there is no appeal; but, in certain cases, two judges sit with the Bureau and assist in deciding whether a patent should be granted or not. The duration of a patent is to be five, ten, or fifteen years, according to the amount paid in fees. The patent, of course, passes by assignment *inter vivos*, or to the patentee's heir, but nothing is provided for the cases of bankruptcy or marriage.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus* ♂) from India, presented by Miss Caroline Newton; a Leopard (*Felis pardus* ♂), a Lesser Koodoo (*Strepsiceros imberbis* ♂) Malindi, East Africa, two White-crested Touracous (*Corythaix albocristata*) from South Africa, presented by Mr. G. S. Mackenzie; a Common Squirrel (*Sciurus vulgaris*) British, presented by Mrs. Arthur Faulkner; an Indian Wolf (*Canis pallidus*) from Afghanistan, five Chaplain Crows (*Corvus capellanus*), an Indian Python (*Python molurus*) from Fao, Persian Gulf, presented by Mr. B. T. Ffinch, C.M.Z.S.; two Slender-billed Cockatoos (*Cacatua tenuirostris*) from Australia, presented respectively by Mr. Walter Bird and Mrs. Hunt; an Eagle (*Aquila* sp. inc.) from Foochow, China, presented by Messrs. J. de la Touche and George Siemosen; two Alligators (*Alligator mississippiensis*) from Florida, deposited; a Wanderoo Monkey *Macacus silenus* ♀) from the Malabar Coast of India, an Indian White Crane (*Grus leucogeranos*), six Rose-coloured Pastors (*Pastor roseus*) from India, three Elliot's Pheasants (*Phasianus ellioti* ♂ ♀ ♀), thre Amherst's Pheasants (*Thaumalea amherstiæ* ♂ ♀ ♀) from China, two Swinhoe's Pheasants (*Euplocamus swinhoii* ♂ ♀) from Formosa, two Vulturine Guinea Fowls (*Numida vulturina* ♂ ♀) from East Africa, two Crested Screamers (*Chauna chavaria*) from Buenos Ayres, two Pochards (*Fuligula ferina* ♂ ♂), European, purchased; two Viscachas (*Lagostomus trichodactylus*), a Vulpine Phalanger (*Phalangista vulpina* ♂), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE CONSTITUTION OF CELESTIAL SPACE.—M. G. A. Hirn has recently published an able and interesting work, entitled "Constitution de l'Espace Céleste," in which he inquires into the nature of the medium or agent which establishes and carries on the relationships of the celestial bodies. For all of these, from the most enormous sun to the most infinitesimal meteorite, are in constant relationship to each other, continually attracting each other, continually radiating and receiving light and heat. Newton long ago regarded it as the greatest of absurdities to imagine "that one body might act upon another at a distance, through a vacuum, without the mediation of anything else, by and through which their action and force may be conveyed from one to another. Gravity," he added, "must be caused by an agent acting constantly according to certain laws; but whether this agent be material or immaterial, I have left to the consideration of my readers."

This question, left unsolved by Newton, Hirn answers as follows:—"The thorough analysis of the most diverse facts revealed to us by science to-day allows us to reply to the first question by the most absolute negation. That which fills space and which establishes relations between the celestial bodies is not diffuse matter."

That "ponderable matter in the state of a diffuse gas" does not fill interplanetary and interstellar space M. Hirn seeks to prove by inquiring what effect such a medium would have on the various members of the solar system, and particularly upon their movements. Many of his conclusions are exceedingly striking, and if accepted certainly prove his main proposition given above. Perhaps the most remarkable is that relating to the secular acceleration of the moon. To explain a secular acceleration of 0″·5 in the mean motion of the moon it would be sufficient if 1 kilogramme of gas were distributed over 975,000 cubic kilometres of space; a rarefaction one million times greater than that of a Crookes vacuum of the millionth of an atmosphere. But the effect of the shock of the particles of this rarefied gas against a body like the moon as it moved forward in its orbit would be to raise the gas to a temperature of